(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 696 422 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
09.06.1999 Bulletin 1999/23

(51) Int. Cl.[6]: **A01K 87/00**, A01K 87/04, B29C 53/62

(21) Application number: **95305469.9**

(22) Date of filing: **04.08.1995**

(54) **Hollow telescopic fishing rod and method of manufacturing same**

Hohle Teleskop-Angelrute und Verfahren zu ihrer Herstellung

Canne à pêche télescopique creuse et procédé pour la fabrication de cette canne

(84) Designated Contracting States:
DE FR GB IT

(30) Priority: **10.08.1994 JP 18798694**

(43) Date of publication of application:
14.02.1996 Bulletin 1996/07

(73) Proprietor: **Shimano Inc.**
Osaka 590-0824 (JP)

(72) Inventors:
- **Morimoto, Kazuya**
  Sakai-shi, Osaka (JP)
- **Utsuno, Nobuyoshi**
  Sakai-shi, Osaka (JP)
- **Tokuda, Isamu**
  Sakai-shi, Osaka (JP)

(74) Representative:
Pacitti, Pierpaolo A.M.E. et al
Murgitroyd and Company
373 Scotland Street
Glasgow G5 8QA (GB)

(56) References cited:

DE-A- 4 203 579	**FR-A- 2 029 828**
FR-A- 2 123 967	**GB-A- 1 127 756**
GB-A- 1 526 582	**GB-A- 2 165 431**
US-A- 2 777 239	

- **PATENT ABSTRACTS OF JAPAN, unexamined applications, C field, vol. 14, no. 96, February 22, 1990 THE PATENT OFFICE JAPANESE GOVERNMENT page 46 C 692; & JP-A-01 304 836 (DAIWA SEIKO INC.)**
- **PATENT ABSTRACTS OF JAPAN, unexamined applications, C field, vol. 13, no. 427, September 22, 1989 THE PATENT OFFICE JAPANESE GOVERNMENT page C 639; & JP-A-01 165 328 (OLYMPIC CO. LTD.)**

EP 0 696 422 B1

Description

Field of the Invention

[0001] This invention relates to a hollow telescopic fishing rod in which concave portions and convex portions are formed on the inner circumferential surface of a fishing rod body comprising a material made from resin and reinforcing fibers, and to its manufacturing method.

Background of the Invention

[0002] The applicant has already proposed a hollow telescopic fishing rod (Japanese Utility Application No. 88259/93) where a fishing line extends through the hollow center of the fishing rod. The gist of the proposal is the formation of concave/convex inner-circumferential surface in the fishing rod material made from resin and reinforcing fibers. By such a structure, a fishing line can be held by the convex portions and lifted up from the inner-surface of the fishing rod so that the friction resistance which is generated by winding and unwinding of the fishing line can be mitigated. If a spiral is stored within the fishing rod and forms convex portions as shown in the Japanese Patent Application No. 304836/89, for example, there is a problem that this spiral could come off the inner-surface of the fishing rod when the rod is bent because the convex portions and the inner-surface are separate things. In the prior application stated in the Japanese Utility Application No. 88259/93, however, the inner-surface of the fishing rod itself forms convexes. Therefore, the convex portions should not come off when the fishing rod is bent. A further prior art example is known for instance from FR-A-2,123,967.

[0003] As mentioned above, though the prior art has already had a basic effect that the convex portions hardly come off the inner-surface of the fishing rod, this structure does not offer sufficient strength for use in a long run as the fishing rod material itself forms convex portions. Therefore, some countermeasure has been needed to solve this problem.

Summary of the Preferred Embodiments

[0004] The objective of this invention is to place reinforcing fibers in order to further strengthen the aforesaid basic effect.

[0005] A characteristic structure offered by this invention is formation of the inner circumferential surface of the fishing rod body, comprising a material which is made from resin and reinforcing fibers, in a concave/convex shape as well as application of reinforcing fibers which are disposed and extended in the convex portions in the circumferential direction only.

[0006] By applying reinforcing fibers to the convex portion, the convex portion itself can be reinforced by the fibers. Hence, strength against curvature caused by contacts of the line at times of winding and unwinding can be improved.

[0007] By this working, abrasion of the convex portions can be restrained even in use for long periods of time, and stable line-holding function can be ensured. Furthermore, as the reinforcing fibers are set in the direction of the circumference of the fishing rod, the load of the line can be received by the reinforcing fibers which are placed to cross the line at about a right angle even if the contact point between the line and a convex portion is moved in the circumferential direction.

[0008] Other objects, features and advantages of the present invention will become apparent to those skilled in the art from the following detailed description. It is to be understood, however, that the detailed description and specific examples, while indicating preferred embodiments of the present invention, are given by way of illustration and not limitation. Many changes and modifications within the scope of the present invention may be made and the invention includes all such modifications, within the scope of the appended claims.

Brief Description of the Drawings

[0009] The invention may be more readily understood by referring to the accompanying drawings in which

FIGS. 1(a)-(d) are perspective views to show the first processes in the fishing rod manufacturing processes, in which FIG. 1(a) illustrates applying the wax; FIG 1(b) illustrates winding the mold releasing tape; FIG. 1(c) illustrates winding the concave/convex forming tape; and FIG. 1(d) illustrates winding the mold releasing tape.

FIG. 2(a)-(d) are perspective views to show the interim processes in the fishing rod manufacturing processes, in which FIG. 2(a) shows winding the prepreg tape of the first layer; FIG. 2(b) shows winding the prepreg pattern; FIG 2(c) shows winding the prepreg tape of the second layer; and FIG. 2(d) shows winding the form-maintaining tape.

FIGS. 3(a)-(c) are perspective views to show the last processes in the fishing rod manufacturing processes, in which FIG. 3(a) illustrates hardening the fishing rod; FIG. 3(b) illustrates peeling off the form-maintaining tape; and FIG. 3(c) illustrates peeling off the concave/convex forming tape.

FIG. 4 is a longitudinal side-view to show the cross-sectional structure corresponding to Fig. 2(d).

FIG. 5 is a longitudinal side-view to show the configuration of the concave/convex surface.

FIG. 6 is a longitudinal side-view to show the laminated structure shown in Fig. 4 less the mold releasing tape and the wax.

FIG. 7 is a longitudinal side-view to show the cross-section of the fishing rod of 3-layer structure.

FIG. 8 is a longitudinal side-view to show a struc-

ture of combination of prepreg in which reinforcing fibers are placed in the axial direction and glass cloth fibers.

FIG. 9 is a longitudinal side-view to show the cross-section of the convex portion in a trapezoid.

FIG. 10 is a longitudinal side-view to show the configuration of the concave/convex surface formed in tiers.

FIG. 11 is a longitudinal side-view to show a situation in which a line holder is attached to the concave/convex surface.

FIG. 12 is a sectional view to show the 4-layer structure.

Detailed Description of the Preferred Embodiments

[0010] A preferred embodiment of the present invention affords quick discharge of water brought into the fishing rod by making flow of the water smooth. A structure employed for this purpose is that the concave/convex surface in the structure of the inventive fishing rod assumes tiers whose diameter gets smaller as it gets closer to the front end. Its working and effect are as follows: When the fishing rod is placed vertically, water brought into the rod runs down the concave/convex inner surface and is collected at either end of the rod. The water can be discharged out from the aperture at the front end of the rod or a hole made in order to insert the line from a reel into the rod. Thanks to this structure, there will be almost no chances for water attached to the inner-surface of the rod, etc. to touch the line.

[0011] Furthermore, as the reinforcing fibers are placed in the circumferential direction of the fishing rod, the reinforcing fibers and the concave/convex surface in tiers are positioned in approximately the same direction. Therefore, the reinforcing fibers conform with the uneven concave/convex inner surface of the rod since some of the reinforcing fibers are wound circumferentially around the rod during the construction of the rod. Hence, the reinforcing fibers provide strength and support throughout the rod length, including within the uneven inner surface of the rod, since the reinforcing fibers are disposed within the concave/convex surface portions of the rod. Therefore, the reinforcing fibers can fully exert their reinforcement effect for the convex portions.

[0012] According to another preferred embodiment of the present invention, the concave/convex surface in the structure of the inventive fishing rod assumes a spiral whose diameter is reduced as it gets closer to the front end. Its working and effect are as follows: When the fishing rod is placed vertically, water brought into the fishing rod runs down the continuously-helical surface. Therefore, it is easier for water to run down than in case of the concave/convex surface in tiers, hence discharge of water from the fishing rod is even easier. Also, when the fishing rod is shaken, the water can run along the spiral and be discharged from the spearhead of the fishing rod.

[0013] An additional preferred embodiment of the present invention makes formation of the concave/convex inner-surface of the fishing rod comparatively easy, and offers a device which can mitigate the friction resistance of the line at times of winding and unwinding of the fishing line. According to this preferred embodiment, the inner circumferential surface of the fishing rod body is formed into concave/convex shape by applying a mold releasing agent to a mold core; winding concave/convex forming tape to form the aforesaid concave/convex surface round the outer circumferential surface of the mandrel to which the mold releasing agent is applied in the axial direction of the mandrel at fixed intervals, thereby forming a mold core; forming a fishing rod body by winding a fishing rod material made from resin and reinforcing fibers around the mold core, and winding form-maintaining tape round the outer circumferential surface of the aforementioned fishing rod body; and subsequently hardening the fishing rod body, removing the mandrel, peeling off the form-maintaining tape and releasing the concave/convex forming tape from the fishing rod body.

[0014] Its working and effect are as follows: By winding concave/convex forming tape in the axial direction at fixed intervals, forming gaps therebetween, the aforementioned fishing rod material comes into the gaps of the concave/convex forming tape during hardening. When the concave/convex forming tape is removed after hardening, the tape-removed portion remains as concave portions and the portion where the fishing rod material has come into remains as convex portions. Thus, concave/convex surface is formed inside the fishing rod body.

[0015] This method can contribute to cost reduction as it employs an easy manufacturing method of simply winding tape at certain intervals in order to form a concave/convex surface.

[0016] Wax is applied to the mold core before forming the convex surface, and therefore, the wax remains on the convex portions of the inner surface of the rod even after removal of the mold core. This wax exerts a water-repellent effect and, at the same time, serves as sliding agent being positioned between the convex portions and the line which touches the convex portions. This results in further reduction of the friction resistance between the inner surface of the rod and the line.

[0017] A further preferred embodiment of the present invention provides a method of manufacturing hollow telescopic fishing rods by which concave/convex forming tape can be removed easily after hardening. According to this preferred embodiment, a mold releasing tape is wound between the mold releasing agent and the concave/convex forming tape, and between the concave/convex forming tape and the fishing rod body. By this winding, removal after hardening becomes easier, a concave/convex surface can be formed as expected, and there will be no increase in the friction resistance

made by the line.

[0018] Still another preferred embodiment of the present invention positions reinforcing fibers in the concave portions and convex portions in the inner surface of the fishing rod so that they can fully exert their reinforcement effect. According to this preferred embodiment, a fishing rod body is formed by the first layer where narrow prepreg tape, in which reinforcing fibers are placed in the circumferential direction, is placed along the circumferential direction as well as in the axial direction at fixed intervals, and the second layer where prepreg tape, which is composed of reinforcing fibers and resin, is placed in the axial direction without any intervals in order to form the inner circumferential surface of the fishing rod body into a concave/convex shape.

[0019] Its working and effect are as follows: Forming a concave/convex surface mitigates the friction resistance made by the line at times of winding and unwinding. At the same time, as the reinforcing fibers of the first layer which forms a convex portion are placed in the circumferential direction, the reinforcing fibers can exert their reinforcement effect for the convex portion even if the contact point between the line and the convex portion moves in the circumferential direction because the reinforcing fibers are still there. Furthermore, the aforementioned second layer has reinforcing fibers that are also placed about the mold core in the circumferential direction. The reinforcing fibers thus do not meander from the position where they should be placed and they can fully exert their reinforcement function for the convex portions.

[0020] Yet another preferred embodiment of the present invention offers a hollow telescopic fishing rod which can maintain a basic strength as a fishing rod while maintaining the advantages of the foregoing embodiment. According to this preferred embodiment, the direction of the reinforcing fibers of the prepreg is set in the aforesaid second layer at the circumferential direction as described above.

[0021] Its working and effect are as follows: As reinforcing fibers of the second layer, which are placed without any intervals in the axial direction and practically form the inner-most layer, are set in the circumferential direction, the reinforcing fibers placed in the circumferential direction can work even if the section of the fishing rod is deformed into an elongate oval when the fishing rod is bent, and can prevent the fishing rod from breaking down by pressure.

[0022] According to another preferred embodiment of the present invention, the reinforcing fibers of the prepreg in the second layer are set at the axial direction, and cross fibers are inserted. The reinforcing fibers cross each other.

[0023] Its working and effect are as follows: As reinforcing fibers are applied in the axial direction, the reinforcing fibers can work for the tensile strength which works in the axial direction in order to maintain the strength, and the cross fibers can slightly resist against the deformation pressure to deform the fishing rod section into an elongate oval.

[0024] What is more, the cross fibers can restrain scattering of the reinforcing fibers in the axial direction when winding and forming the first layer round the mold core.

[0025] An additional preferred embodiment of the present invention provides a device which allows the reinforcing fibers placed in the axial direction to exert their reinforcement function, while facilitating manufacture and mitigating friction resistance of the line at times of winding and unwinding. According to this preferred embodiment, mold releasing agent is applied to the mandrel; concave/convex forming tape is wound to form the concave portions and convex portions around the outer circumferential surface of the mandrel to which the mold releasing agent is applied in the axial direction of the mandrel at fixed intervals, thereby forming a mold core; the fishing rod body is formed by winding prepreg tape around the mold core as the first layer, which has the same thickness and is set at the same fixed intervals as the concave/convex forming tape and which contains resin and reinforcing fibers in the circumferential direction, so that it is positioned within the aforesaid fixed intervals of the concave/convex forming tape, winding prepreg tape made from resin and reinforcing fibers set in the circumferential direction over the first layer as the second layer and winding prepreg comprising resin and reinforcing fibers set in the axial direction over the second layer as the third layer. Form-maintaining tape is then wound round the outer circumferential surface of the fishing rod body. The fishing rod body is then hardened, the mandrel is removed, the form-maintaining tape is peeled off, and the concave/convex forming tape is peeled off from the fishing rod body in order to form the inner circumferential surface in the fishing rod body into a concave/convex surface.

[0026] Its working and effect are as follows: By winding the concave/convex forming tape round the mandrel in the axial direction at fixed intervals and placing the prepreg tape as the first layer within the intervals of the concave/convex forming tape, when the concave/convex forming tape is removed after hardening, the prepreg tape as the first layer remains and forms a concave/convex surface together with the second layer.

[0027] The prepreg tape and the concave/convex forming tape are in effect wound in parallel rings without any gaps, each ring having generally the same thickness, thus forming an even layer on the mold core. Thus, by employing a manufacturing method to wind round the prepreg tape which has the same thickness as the concave/convex forming tape at the aforesaid fixed intervals, difference in outer level between the concave/convex forming tape and prepreg tape is eliminated. Hence, the second and the third layers can be wound round the even surface. Therefore, the reinforcing fibers placed in the axial direction will not meander

from where they should be placed, and the function of the reinforcing fibers can be exerted as it is expected.

[0028] Reference will be made to Figures 1-12 in the following explanation of manufacturing processes according to the invention.

[0029] According to a preferred manufacturing procedure of the invention, wax 10 is applied as a mold releasing agent to mandrel 12 as shown in Fig. 1(a). The mandrel 12 is an elongated tapered shaft to define the basic shape of the subsequently produced hollow fishing rod. Polyester tape 14 for mold releasing is wound over mandrel 12 closely (preferably leaving an unwrapped length at either end of mandrel 12) so that the side of a rotation of tape 14 either overlaps or abuts the side of the next rotation so that no gaps are formed between adjacent windings, as shown in Fig. 1(b). Tape 16 for concave/convex forming is wound in the axial direction of the mandrel 12 at fixed intervals as shown in Fig. 1(c) forming gaps between windings. The base material of this tape 16 to form a concave/convex surface is cloth and is required to have flexibility to cope with the mandrel 12, thermal resistance to maintain accuracy of the concave/convex surface and stretching-resistance to maintain accuracy of the fixed intervals in the axial direction of the mandrel 12. As shown in Fig. 1(d), polyester tape 18 is wound closely over the concave/convex forming tape 16 so that the side of a rotation of tape 18 abuts or overlaps the side of the next rotation of tape 18. By doing this, removal of concave/convex forming tape 16 becomes easy.

[0030] The mandrel 12 wrapped by tapes 14, 16 and 18 forms a "mold core."

[0031] Oily wax **20** then is applied to the polyester tape 18 wound over concave/convex forming tape 16 so that concave/convex forming tape 16 is peeled off in a good condition. This oily wax **20** is designed to remain on the inner surface of the fishing rod (equivalent to concave portion 32 and convex portion 34, which will be described later), where concave/convex forming tape 16 has already been taken away, in order to give a water-repellent function to the surface. By this condition, sheet prepreg, which is made of epoxy resin-impregnated carbon fibers placed in the circumferential direction, is cut in the shape of a tape and this tape is closely wound around the mold core so that the side of a rotation of the tape contacts the side of the next rotation to form the inner-most layer 22 as shown in Fig. 2(a). Next, a prepreg sheet 24 is wound around the layer 22, the prepreg sheet 24 being a sheet of prepreg material having unidirectional fibers with epoxy resin therein, extending substantially the length of the mold core, but wound around the entire outer diameter of the mold core so that the fibers extend the longitudinal length of the mold core. After winding prepreg sheet 24 over it to form swelling mating parts at both front and rear ends, a prepreg tape in which carbon fibers are placed in the axial direction is wound closely over prepreg sheet 24 so that the side of a rotation of the tape contacts the side of the next rotation to form the second layer 26 in combination with prepreg sheet 24 as shown in Fig. 2(b). Then, a prepreg tape in which carbon fibers are placed in the circumferential direction, and a prepreg tape in which carbon fibers are placed in the axial direction are wound to form the third and the fourth layers 28 and 30, respectively, and fishing rod body 36 composed of four layers is formed as shown in Fig. 4.

[0032] Over such fishing rod body 36, polyester tape 38 is wound as form-maintaining tape as shown in Fig. 2(d), then is hardened as shown in Fig. 3(a). The rod body can be hardened by any of a variety of hardening means, such as exposing the layers to ultraviolet light, heating the material or adding a hardening agent. Then polyester tape 38 is peeled off after hardening as shown in Fig. 3(b), and concave/convex forming tape 16 is removed together with mold releasing tape 14 and 18 as shown in Fig. 3(c). By such procedures, fishing rod body 36 which has concave portions and convex portions 32, 34 in a spiral on its inner circumferential surface can be formed and fibers can be placed in the circumferential direction within convex portions 34.

[0033] Next, the configurations of concave portions and convex portions 32, 34 are explained. As shown in Fig.5, preferred dimensions of a concave portion 32 and convex portion 34 are as follows: convex portion 34's length = **0.8** - 1.2 mm, concave portion 32's length = 6.7 - 7.3 mm, and convex portion 34's height = 0.4 - 0.6 mm. Cross-sectional configuration of convex portion 34 is close to a square but trapezoid or triangle may also be accepted. Round corners instead of acute corners may also be employed.

[0034] As mentioned above, by forming concave portions 32 and convex portions 34 on the inner circumferential surface of fishing rod body 36, the friction resistance produced at times of winding and unwinding of the fishing line can be reduced almost by half, preferably to 0.3 -**0.7** g in comparison with the ones where no concave/convex surface 32 and 34 is formed. (Other conditions for this calculation are: the minimum diameter and length of fishing rod body 36 are 10 mm and 360 mm, respectively, the diameter of the hard guide ring to be attached inside fishing rod body 36 is 8 mm, and the fishing line preferably is made of polyethylene or nylon and has diameter of 0.285 mm. Of course, other materials and dimensions can be selected as desired.)

[0035] Next, another manufacturing method for fishing rod body 36 is explained. In this method, after applying wax 10 to mandrel 12, concave/convex forming tape 16 is directly wound over it at fixed intervals, and then prepreg tape is wound as the first layer 22 closely so that the side of a rotation of the tape abuts or overlaps the side of the next rotation. The cross-sectional configuration of fishing rod body in the aforesaid case looks as Fig. 6.

[0036] By this method, manufacturing processes can be simplified as it does not need polyester tape 14 and 18 for mold releasing.

[0037] In order to take the aforesaid manufacturing method, concave/convex forming tape 16 must have good releasability by itself as concave/convex forming tape 16 directly touches the first layer 22. By employing the aforesaid manufacturing method, a water-repellent effect is given as wax 10 is applied to convex portions 34 made by the first layer 22, and hydrophilicity is given to concave portions 32 as surface processing is applied to concave/convex forming tape 16. Therefore, water, etc. can be discharged by the water-repellence effect of convex portions 34 which hold the line, resulting in less chances of contacts between the line and water, and discharge of water from the concave portions 32 can be restrained thanks to the hydrophilicity of concave portions 32, which also results in reduced chances of contacts between the line and water.

[0038] The following lamination configurations can also be applied for fishing rod body 36.

[0039] As shown in Fig. 7, prepreg in which reinforcing fibers are placed in the circumferential direction as the first layer 22, prepreg in which reinforcing fibers are placed in the axial direction as the second layer 26, and prepreg in which reinforcing fibers are placed in the circumferential direction as the third layer 28 are wound respectively. Here, the second layer 26 must be more than three times as thick as the first layer 22 and the third layer 28. By such a structure, fibers can be placed in the circumferential direction within convex portions 34 of the concave/convex surface 32, 34 formed in the inner surface of the first layer 22.

[0040] As shown in Fig. 8, fishing rod body 36 may be formed by putting prepreg 40, in which reinforcing fibers are placed in the axial direction, in multiple layers and inserting glass cloth 42, in which reinforcing fibers are placed in two directions, in between the layers of prepreg 40. The manufacturing method in this case preferably is as follows: concave/convex forming tape 16 is wound at the fixed intervals round mandrel 12 to which wax 10 has been applied, and prepreg tape 44 is wound within the intervals to make the height of the surface even. Then, glass cloth 42 is wound over it. By the presence of glass cloth 42 between the layers as such, dispersion of prepreg in which reinforcing fibers are placed in the axial direction can be avoided when it is wound round.

[0041] As shown in Fig. 12, fishing rod body 36 can also be formed by placing prepreg in which reinforcing fibers are set in the circumferential direction as the first layer 22, forming concave portions 32 and convex portions 34 on the inner surface of this first layer 22, placing prepreg in which reinforcing fibers are set in the axial direction as the second layer 26, placing prepreg in which reinforcing fibers are set in the circumferential direction as the third layer 28, and placing prepreg in which reinforcing fibers are set in the axial direction as the outer-most (fourth) layer 30. In this case, the first layer 22, the second layer 26 and the third layer 28 is set to have the same thickness and the fourth layer 30 is wound round in several plies so that it will be three to five times as thick as the first layer 22, and so on. By such a method, fishing rod body 36 with high bending strength can be formed.

[0042] The second layer 26 can be omitted from the aforesaid structure.

[0043] Other configurations of concave portions 32 and convex portions 34 are now explained.

[0044] Concave/convex surface 32, 34 can be formed in a spiral as shown in Fig. 3(c). Convex portions 34 may be in a ring form in this structure. In such a case, when winding concave/convex forming tape 16, tape 16 must be wound round each concave portion 32 to define a ring.

[0045] By forming each convex portion 34 in the form of a ring in the circumferential direction, convex portions 34 and carbon fibers placed in the circumferential direction have the same direction. Therefore, the carbon fibers do not have to be bent as they do not cross the switching point of the concave portions and convex portions. Hence, excellent strength against bending of the fishing rod can be maintained.

[0046] Next, with reference to Fig. 9, the cross-sectional configuration of each convex portion 34 is made into a trapezoid to assure easy removal of concave/convex tape 16 in order to avoid abrasion of the corners of the convex portion. The inventors have investigated the effects of interval "P" in the axial direction of convex portion 34 of concave portions and convex portions 32, 34 in the ring form, and confirmed that, even if the inner diameter of convex portion 34, "D", varies from 1.0 mm, 2.0 mm, 3.0 mm to 4.0 mm, when interval "P" is less than approximately 100 mm, the friction resistance stays around approximately 0.3 - 0.5 g, and when interval "P" is between 100 mm and around 400 mm, there is a tendency that the friction resistance rises at a certain rate till 1.0 g.

[0047] As shown in Fig. 10, concave portions and convex portions 32, 34 may be formed into tiers whose diameter is reduced as it gets closer to the front end. In this case, as sea water, etc. brought inside the fishing rod can move to the tiers in the back without staying, the water can be collected at the rear end of the rod and discharged out.

[0048] Other working structures are now explained.

[0049] As shown in Fig. 11, articles different from concave portions 32 and convex portions 34 can be attached as line holders 46, i.e., a line-inserting hole 48 and a conical guide surface 50 which guides the line to this line-inserting hole 48 are formed as line holder 46, and this line holder 46 is set and fixed, by any desired means such as by adhesive bonding or mechanical compression, in convex portion 34 of concave portions and convex portions 32, 34. As line holder 46 is contained in the concave/convex surface by this procedure, the line held by line holder 46 is maintained at a wider distance from the inner surface of the fishing rod than being held by concave portions and convex portions 32,

34 contributing to further reduction of chances of contacts between water and the line. What is more, even if the line slacks between the two adjacent line holders 46, the aforesaid convex portions 34 can support the line as this portion also has a funtion to hold the line. Therefore, though it is to the lesser extent in comparison with the case of line holders 46, it can still reduce the chances for water to contact the line.

[0050] The aforesaid line holder 46 may be in the form of a ring and its material may be selected from a variety of ceramics, metals and resin.

[0051] Pertaining to the foregoing structure, some elastic deformation may be allowed for convex portions 34 which support line holders 46. Therefore, only by setting in line holders 46, convex portions 34 can hold line holders 46, and no special holding structure is required.

[0052] Not only thermosetting resins (including epoxy and phenolic resins) but also thermoplastic resins, such as nylon, may be used for the prepreg to form the fishing rod. Also, other fibers such as boron fibers, as well as carbon fibers, may be used as reinforcing fibers.

[0053] Thermal-contraction tape may be used as form-maintaining tape 38.

[0054] Not only wax but silicone can also be used as mold releasing agent 10.

[0055] Pertaining to the aforesaid fishing rod body 36, a through hole 52 may be formed in fishing rod body 36 in order to discharge water out through an internal path for the line.

Claims

1. A hollow telescopic fishing rod comprising a rod body comprised of a material made from resin and reinforcing fibres, said rod body having an inner circumferential surface, wherein concave surface portions and convex surface portions are formed in said inner circumferential surface of said rod body, and wherein said reinforcing fibres are disposed and extend in said convex surface portions in the circumferential direction only.

2. A hollow telescopic fishing rod as claimed in Claim 1, said rod having a front end, wherein said concave surface portions and convex surface portions are arranged in tiers the diameters of which decrease as said tiers approach said front end.

3. A hollow telescopic fishing rod as claimed in Claim 1, said rod having a front end, wherein said concave surface portions and convex surface portions are arranged in a spiral the diameter of which decreases as said spiral approaches said front end.

4. A method of manufacturing a hollow telescopic fishing rod comprising the steps of:

   (a) applying a mold releasing agent to a mandrel;

   (b) winding a concave/convex forming tape around the outer circumferential surface of said mandrel to which said mold releasing agent is applied in the axial direction of said mandrel at fixed intervals to form a plurality of concave surface portions and convex surface portions;

   (c) forming a fishing rod body by winding prepreg made from resin and reinforcing fibres around said concave/convex forming tape;

   (d) winding a form-maintaining tape around the outer circumferential surface of said fishing rod body;

   (e) hardening said fishing rod body;

   (f) removing said mandrel and peeling off said form-maintaining tape; and

   (g) releasing said concave/convex forming tape from said fishing rod body to form a concave/convex inner circumferential surface within said fishing rod body.

5. A method as claimed in Claim 4 wherein mold releasing tape is wound between said mold releasing agent and said concave/convex forming tape and between said concave/convex forming tape and said fishing rod body.

6. A hollow telescopic fishing rod comprising a rod body, said rod body having a first layer and a second layer, said rod having an inner circumferential surface, wherein said first layer comprises a narrow prepreg tape containing reinforcing fibres set in the circumferential direction, said tape being placed along the circumferential direction as well as in the axial direction at fixed intervals, and wherein said second layer comprises prepreg tape made from reinforcing fibres and resin applied in the axial direction with no intervals, wherein differences in level between said first layer and said second layer form concave surface portions and convex surface portions on the inner circumferential surface of the fishing rod.

7. A hollow telescopic fishing rod as claimed in Claim 6 wherein the direction of the reinforcing fibres of the prepreg of said second layer is set at the circumferential direction.

8. A hollow telescopic fishing rod as claimed in Claim 6 wherein the direction of the reinforcing fibres of the prepreg in said second layer is set at the axial direction, said rod body further comprising cross

fibres in which reinforcing fibres cross each other inserted between the first layer and the second layer.

9. A method as claimed in Claim 4 wherein said step of forming a fishing rod body comprises

(i) winding prepreg tape as a first layer, which has the same thickness and is set at the same fixed intervals as the concave/convex forming tape and which comprises resin and reinforcing fibres in the circumferential direction, so that it is positioned within said fixed intervals of said concave/convex forming tape,

(ii) winding prepreg tape comprising resin and reinforcing fibres set in the circumferential direction over said first layer as a second layer, and

(iii) winding prepreg tape comprising resin and reinforcing fibres set in the axial direction over said second layer as a third layer having an outer circumferential surface;

and wherein said step of releasing said concave/convex forming tape from said fishing rod body includes peeling off said concave/convex forming tape.

10. A hollow telescopic fishing rod as claimed in any of Claims 1 to 3 or 6 to 8, wherein said convex surface portions have square, rectangular, trapezoidal or triangular cross-sections.

11. A hollow telescopic fishing rod as claimed in any of Claims 1 to 3, 6 to 8 or 10, wherein said reinforcing fibres are carbon fibres, boron fibres or mixtures thereof.

12. A hollow telescopic fishing rod as claimed in any of Claims 1 to 3, 6 to 8, 10 or 11, wherein said resin is a thermoplastic or thermosetting resin.

13. A hollow telescopic fishing rod as claimed in Claim 12 wherein said resin is an epoxy resin.

14. A hollow telescopic fishing rod as claimed in any of Claims 1 to 3, 6 to 8 or 10 to 13, wherein said convex surface portions have a length from about 0.8 to 1.2 mm and a height from about 0.4 to 0.6 mm, and said concave surface portions have a length from about 6.7 to 7.3 mm.

15. A hollow telescopic fishing rod as claimed in any of Claims 1 to 3, 6 to 8 or 10 to 14, further comprising a reel and a fishing line.

16. A hollow telescopic fishing rod as claimed in any of Claims 1 to 3, 6 to 8 or 10 to 15, further comprising a line holder disposed within said rod.

17. A method as claimed in either of Claims 4 or 9 wherein said mold releasing agent applied to the mandrel is selected from the group consisting of waxes and silicones.

18. A method as claimed in any of Claims 4, 9 or 17 wherein said prepreg comprises a thermoplastic or thermosetting resin.

19. The method of Claim 4 or of either of Claims 17 or 18 when dependent upon Claim 4 wherein at least a portion of said reinforcing fibres are oriented in the circumferential direction.

20. A method as claimed in any of Claims 4, 9, 17, 18 or 19 comprising the further steps of:

(a) winding a first release tape around said mandrel, after said application of releasing agent to said mandrel;

(b) winding said concave/convex forming tape around said first release tape in the axial direction of said mandrel at fixed intervals to form a plurality of concave surface portions and convex surface portions;

(c) winding a second release tape around said concave/convex forming tape;

(d) winding the prepreg comprising a resin and reinforcing fibres around said second release tape to form said fishing rod body, said resin being a thermoplastic or thermosetting resin; and

(e) after winding said form-maintaining tape around the outer circumferential surface of said fishing rod body, hardening said fishing rod body and removing said mandrel and peeling off said form-maintaining tape, then releasing said first and second release tapes and said concave/convex forming tape from said fishing rod body to form a concave/convex inner circumferential within said fishing rod body.

Patentansprüche

1. Eine hohle Angelrute bestehend aus einem Rutenkörper, der von einem Material aus Harz und Verstärkungsfasern ausgemacht wird, wobei der Rutenkörper eine innere Umfangsfläche hat, wobei konkave Flächenteile und konvexe Flächenteile in der inneren Umfangsfläche des Rutenkörpers

gebildet werden und wobei die Verstärkungsfasern in den konvexen Flächenteilen nur in die Umfangsrichtung angebracht sind und sich nur in diese ausdehnen.

2. Hohle Angelrute gemäß Anspruch 1, wobei die Rute ein vorderes Ende hat, wobei die konkaven Flächenteile und die konvexen Flächenteile schichtenweise angeordnet sind, wobei der Durchmesser der Schichten zu dem vorderen Ende hin abnimmt.

3. Hohle Angelrute gemäß Anspruch 1, wobei die Rute ein vorderes Ende hat, wobei die konkaven Flächenteile und die konvexen Flächenteile spiralförmig angeordnet sind, wobei der Durchmesser der Spiralen zu dem vorderen Ende hin abnimmt.

4. Ein Verfahren zur Herstellung einer hohlen Teleskop-Angelrute bestehend aus den folgenden Schritten:

   (a) Auftragen eines Formentrennmittels auf einen Dorn;

   (b) Umwickeln der äußeren Umfangsfläche des Dorns, auf den das Formentrennmittel aufgetragen wurde, mit einem eine konkave/konvexe Form gebenden Band in die axiale Richtung des Dorns in bestimmten Abständen, um eine Vielzahl von konkaven Flächenteilen und konvexen Flächenteilen zu bilden;

   (c) Formen eines Angelrutenkörpers, indem Prepreg aus Harz und Verstärkungsfasern um das eine konkave/konvexe Form gebende Band gewickelt wird;

   (d) Umwickeln der äußeren Umfangsfläche des Angelrutenkörpers mit einem formbeibehaltenden Band;

   (e) Aushärten des Angelrutenkörpers;

   (f) Entfernen des Dorns und Abziehen des formbeibehaltenden Bandes; und

   (g) Ablösen des eine konkave/konvexe Form gebenden Bandes von dem Angelrutenkörper, um eine konkave/konvexe innere Umfangsfläche in dem Angelrutenkörper zu formen.

5. Verfahren gemäß Anspruch 4, wobei ein Formentrennband zwischen das Formentrennmittel und das eine konkave/konvexe Form gebende Band und zwischen das eine konkave/konvexe Form gebende Band und den Angelrutenkörper gewickelt wird.

6. Hohle Teleskop-Angelrute bestehend aus einem Rutenkörper, wobei der Rutenkörper aus einer ersten und einer zweiten Schicht besteht, wobei die Rute eine innere Umfangsfläche hat, wobei die erste Schicht ein enges Prepregband enthält, das in die Umfangsrichtung angeordnete Verstärkungsfasern beinhaltet, wobei das Band in bestimmten Abständen entlang der Umfangsrichtung sowie in die axiale Richtung angebracht ist, und wobei die zweite Schicht ein Prepregband aus Verstärkungsfasern und Harz enthält, das ohne Abstände in die axiale Richtung aufgetragen wird, wobei die Niveauunterschiede zwischen der ersten Schicht und der zweiten Schicht konkave Flächenteile und konvexe Flächenteile auf der inneren Umfangsfläche der Angelrute bilden.

7. Hohle Teleskop-Angelrute gemäß Anspruch 6, wobei die Richtung der Verstärkungsfasern des Preprегs der zweiten Schicht in die Umfangsrichtung festgelegt ist.

8. Hohle Teleskop-Angelrute gemäß Anspruch 6, wobei die Richtung der Verstärkungsfasern des Prepregs in der zweiten Schicht in die axiale Richtung festgelegt ist, wobei der Rutenkörper weiterhin Querfasern, in denen Verstärkungsfasern einander kreuzen, beinhaltet, die zwischen der ersten Schicht und der zweiten Schicht eingeschoben werden.

9. Verfahren gemäß Anspruch 4, wobei der Schritt zum Formen eines Angelrutenkörpers aus folgendem besteht

   (i) Umwickeln mit einem Prepregband, das die selbe Dicke hat und mit den gleichen bestimmten Abständen wie das eine konkave/konvexe Form gebende Band angebracht ist und das Harz und Verstärkungsfasern in die Umfangsrichtung beinhaltet, als eine erste Schicht, so daß es innerhalb der bestimmten Abstände des eine konkave/konvexe Form gebenden Bands liegt,

   (ii) Umwickeln der ersten Schicht mit einem Prepregband, das aus Harz und Verstärkungsfasern, die in Umfangsrichtung angebracht sind, besteht, als eine zweite Schicht, und

   (iii) Umwickeln der zweiten Schicht mit einem Prepregband, das aus Harz und Verstärkungsfasern, die in die axiale Richtung angebracht sind, besteht, als eine dritte Schicht, die eine äußere Umfangsfläche hat;

   und wobei der Schritt zum Lösen des eine konkave/konvexe Form gebenden Bands von dem

Angelrutenkörper das Abziehen des eine konkave/konvexe Form gebenden Bands beinhaltet.

10. Hohle Teleskop-Angelrute gemäß einem der Ansprüche 1 bis 3 oder 6 bis 8, wobei die konvexen Flächenteile quadratische, rechteckige, trapezförmige oder dreieckige Querschnitte haben.

11. Hohle Teleskop-Angelrute gemäß einem der Ansprüche 1 bis 3, 6 bis 8 oder 10, wobei die Verstärkungsfasern Kohlenstofffasern, Borfasern oder Mischungen davon sind.

12. Hohle Teleskop-Angelrute gemäß einem der Ansprüche 1 bis 3, 6 bis 8, 10 oder 11, wobei das Harz ein thermoplastisches oder aushärtendes Harz ist.

13. Hohle Teleskop-Angelrute gemäß Anspruch 12, wobei das Harz ein Epoxidharz ist.

14. Hohle Teleskop-Angelrute gemäß einem der Ansprüche 1 bis 3, 6 bis 8 oder 10 bis 13, wobei die konvexen Flächenteile ungefähr 0,8 bis 1,2 mm lang und ungefähr 0,4 bis 0,6 mm hoch sind und die konkaven Flächenteile ungefähr 6,7 bis 7,3 mm lang sind.

15. Hohle Teleskop-Angelrute gemäß einem der Ansprüche 1 bis 3, 6 bis 8 oder 10 bis 14, die weiterhin eine Kurbel und eine Angelschnur beinhaltet.

16. Hohle Teleskop-Angelrute gemäß einem der Ansprüche 1 bis 3, 6 bis 8 oder 10 bis 15, die weiterhin aus einer auf der Rute angebrachten Schnurhalterung besteht.

17. Verfahren gemäß Anspruch 4 oder 9, wobei das auf den Dorn aufgetragene Formentrennmittel von einer aus Wachs- und Silikonarten bestehenden Gruppe ausgewählt wird.

18. Verfahren gemäß einem der Ansprüche 4, 9 oder 17, wobei das Preprep aus einem thermoplastischen oder aushärtenden Harz besteht.

19. Verfahren gemäß Anspruch 4 oder einem der Ansprüche 17 oder 18 wenn in Abhängigkeit von Anspruch 4, wobei zumindest ein Teil der Verstärkungsfasern in die Umfangsrichtung ausgerichtet ist.

20. Verfahren gemäß einem der Ansprüche 4, 9, 17, 18 oder 19, bestehend aus den folgenden weiteren Schritten:

    (a) Umwickeln des Dorns mit einem ersten Lösungsband nachdem das Trennmittel auf den Dorn aufgetragen worden ist;

    (b) Umwickeln des ersten Lösungsbands mit dem eine konkave/konvexe Form gebenden Band in die axiale Richtung des Dorns in bestimmten Abständen, um eine Vielzahl von konkaven Flächenteilen und konvexen Flächenteilen zu bilden;

    (c) Umwickeln des eine konkave/konvexe Form gebenden Bands mit einem zweiten Lösungsband;

    (d) Umwickeln des zweiten Lösungsbands mit dem ein Harz und Verstärkungsfasern beinhaltenden Prepreg, um den Angelrutenkörper zu formen, wobei das Harz ein thermoplastisches oder aushärtendes Harz ist; und

    (e) Nach Umwickeln der äußeren Umfangsfläche der Angelrute mit dem formbeibehaltenden Band, Aushärten des Angelrutenkörpers und Entfernen des Dorns und Abziehen des formbeibehaltenden Bands, anschließendes Lösen des ersten und zweiten Lösungsbandes und des eine konkave/konvexe Form gebenden Bands von dem Angelrutenkörper um einen konkaven/konvexen inneren Umfang in dem Angelrutenkörper zu formen.

Revendications

1. Une canne à pêche télescopique creuse comprenant un corps de canne constitué d'un matériau fait à partir de résine et de fibres de renfort, ledit corps de canne ayant une surface de circonférence interne, dans laquelle des portions de surface concaves et des portions de surface convexes sont formées dans ladite surface de circonférence interne du dit corps de canne, et dans laquelle lesdites fibres de renfort sont disposées et s'étendent dans lesdites portions de surface convexes dans le sens de la circonférence uniquement.

2. Une canne à pêche télescopique creuse selon la revendication 1, ladite canne ayant une extrémité avant, dans laquelle lesdites portions de surface concaves et portions de surface convexes sont arrangées en rangées dont le diamètre diminue au fur et à mesure que lesdites rangées approchent de l'extrémité avant.

3. Une canne à pêche télescopique creuse selon la revendication 1, ladite canne ayant une extrémité avant, dans laquelle lesdites portions de surface concaves et portions de surface convexes sont arrangées en spirales dont le diamètre diminue au fur et à mesure que les spirales approchent de

l'extrémité avant.

4. Un procédé de fabrication d'une canne à pêche télescopique creuse comprenant les étapes consistant à:

(a) appliquer un agent de démoulage sur un mandrin;

(b) enrouler une bande de formage concave/convexe autour de la surface de circonférence externe du dit mandrin sur lequel est appliqué ledit agent de démoulage dans le sens axial du dit mandrin à intervalles fixes pour former une pluralité de portions de surface concaves et de portions de surface convexes;

(c) former un corps de canne à pêche en enroulant un préimprégné fait à partir de résine et de fibres de renfort autour de ladite bande de formage concave/convexe;

(d) enrouler une bande de conservation de forme autour de la surface de circonférence externe du dit corps de canne à pêche;

(e) faire durcir ledit corps de canne à pêche;

(f) retirer ledit mandrin et décoller ladite bande de conservation de forme; et

(g) décoller ladite bande de formage concave/convexe du dit corps de canne à pêche pour former une surface de circonférence interne concave/convexe à l'intérieur du dit corps de canne à pêche.

5. Un procédé selon la revendication 4 dans lequel une bande de démoulage est enroulée autour du dit agent de démoulage et de ladite bande de formage concave/convexe et entre ladite bande de formage concave/convexe et ledit corps de canne à pêche.

6. Une canne à pêche télescopique creuse comprenant un corps de canne, ledit corps de canne ayant une première couche et une seconde couche, ladite canne ayant une surface de circonférence interne, dans laquelle ladite première couche comprend une bande étroite de préimprégné contenant des fibres de renfort fixées dans le sens de la circonférence, ladite bande étant placée sur la longueur dans le sens de la circonférence aussi bien que dans le sens axial à intervalles fixes, et dans laquelle ladite seconde couche comprend une bande de préimprégné faite à partir de fibres de renfort et de résine appliquée dans le sens axial sans intervalles, dans laquelle les différences de niveau entre ladite première couche et ladite seconde couche forment des portions de surface concaves et des portions de surface convexes sur la surface de circonférence interne de la canne à pêche.

7. Une canne à pêche télescopique creuse selon la revendication 6 dans laquelle le sens des fibres de renfort du préimprégné de ladite seconde couche est fixé dans le sens de la circonférence.

8. Une canne à pêche télescopique creuse selon la revendication 6 dans laquelle le sens des fibres de renfort du préimprégné dans ladite seconde couche est fixé dans le sens axial, ledit corps de canne comprenant en outre des fibres transversales dans lesquelles des fibres de renfort se croisent insérées entre la première couche et la seconde couche.

9. Un procédé selon la revendication 4 dans lequel ladite étape de formation d'un corps de canne à pêche comprend

(i) l' enroulement d'une bande de préimprégné en tant que première couche, qui a la même épaisseur et est placée aux mêmes intervalles fixes que la bande de formage concave/convexe et qui comprend de la résine et des fibres de renfort dans le sens de la circonférence, de manière à ce qu'elle soit placée à l'intérieur des dits intervalles fixes de ladite bande de formage concave/convexe,

(ii) l'enroulement d'une bande de préimprégné comprenant de la résine et des fibres de renfort fixées dans le sens de la circonférence au dessus de ladite première couche en tant que seconde couche, et

(iii) l'enroulement d'une bande de préimprégné comprenant de la résine et des fibres de renfort fixées dans le sens axial au dessus de ladite seconde couche en tant que troisième couche ayant une surface de circonférence externe;

et dans lequel ladite étape consistant à décoller ladite bande de formage concave/convexe du dit corps de canne à pêche comprend le décollage de ladite bande de formage concave/convexe.

10. Une canne à pêche télescopique creuse selon l'une quelconque des revendications 1 à 3 ou 6 à 8, dans laquelle lesdites portions de surface convexes ont des sections transversales carrées, rectangulaires, trapézoïdes ou triangulaires.

11. Une canne à pêche télescopique creuse selon l'une quelconque des revendications 1 à 3, 6 à 8 ou 10,

dans laquelle lesdites fibres de renfort sont des fibres de carbone, des fibres de bore ou des mélanges des deux.

12. Une canne à pêche télescopique creuse selon l'une quelconque des revendications 1 à 3, 6 à 8, 10 ou 11, dans laquelle ladite résine est une résine thermoplastique ou thermodurcissable.

13. Une canne à pêche télescopique creuse selon la revendication 12 dans laquelle ladite résine est une résine époxyde.

14. Une canne à pêche télescopique creuse selon l'une quelconque des revendications 1 à 3, 6 à 8 ou 10 à 13, dans laquelle lesdites portions de surface convexes ont une longueur allant d'environ 0,8 à 1,2 mm et une hauteur allant d'environ 0,4 à 0,6 mm, et lesdites portions de surface concaves ont une longueur allant d'environ 6,7 à 7,3 mm.

15. Une canne à pêche télescopique creuse selon l'une quelconque des revendications 1 à 3, 6 à 8 ou 10 à 14, comprenant en outre un moulinet et un fil à pêche.

16. Une canne à pêche télescopique creuse selon l'une quelconque des revendications 1 à 3, 6 à 8 ou 10 à 15, comprenant en outre un support de fil disposé à l'intérieur de ladite canne.

17. Un procédé selon l'une quelconque des revendications 4 à 9 dans lequel ledit agent de démoulage appliqué sur le mandrin est choisi dans le groupe comprenant les cires et les silicones.

18. Un procédé selon l'une quelconque des revendications 4, 9 ou 17 dans lequel ledit préimprégné comprend une résine thermoplastique ou thermodurcissable.

19. Un procédé selon la revendication 4 ou l'une quelconque des revendications 17 ou 18 lorsqu'elles dépendent de la revendication 4 dans lequel au moins une partie des dites fibres de renfort est orientée dans le sens de la circonférence.

20. Un procédé selon l'une quelconque des revendications 4, 9, 17, 18 ou 19 comprenant en outre les étapes consistant à:

(a) enrouler une première bande de décollage autour du dit mandrin, après ladite application de l'agent de démoulage sur ledit mandrin;

(b) enrouler ladite bande de formage concave/convexe autour de ladite première bande de décollage dans le sens axial du dit mandrin à intervalles fixes pour former une pluralité de portions de surface concaves et de portions de surface convexes;

(c) enrouler une seconde bande de décollage autour de ladite bande de formage concave/convexe;

(d) enrouler le préimprégné comprenant une résine et des fibres de renfort autour de ladite seconde bande de décollage pour former ledit corps de canne a pêche, ladite résine étant une résine thermoplastique ou thermodurcissable; et

(e) après avoir enroulé ladite bande de conservation de forme autour de la surface de circonférence externe du dit corps de canne à pêche, faire durcir ledit corps de canne à pêche et retirer ledit mandrin et décoller ladite bande de conservation de forme, puis décoller lesdites première et seconde bandes de décollage et ladite bande de formage concave/convexe du dit corps de canne à pêche pour former une circonférence interne concave/convexe à l'intérieur du dit corps de canne à pêche.

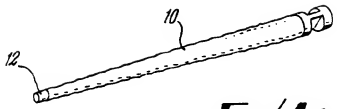

FIG. 1a

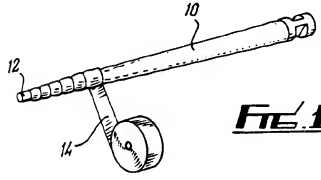

FIG. 1b

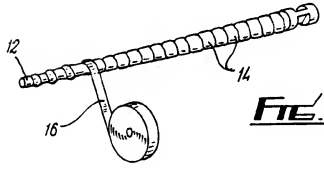

FIG. 1c

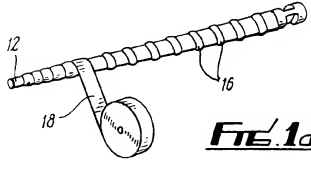

FIG. 1d

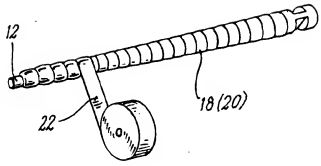

FIG. 2a

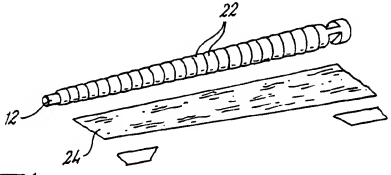

FIG. 2b

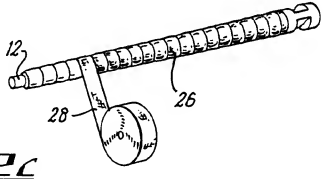

FIG. 2c

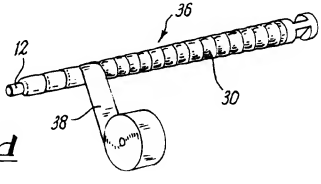

FIG. 2d

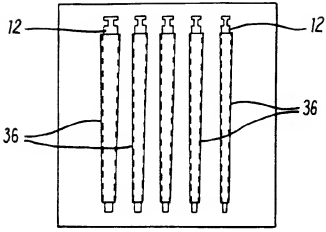

FIG. 3a

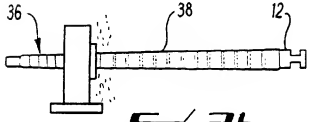

FIG. 3b

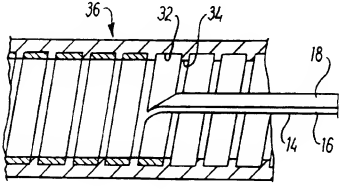

FIG. 3c

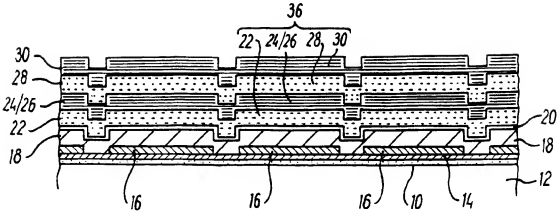

FIG. 4

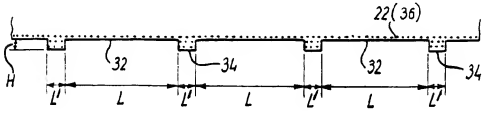

FIG. 5

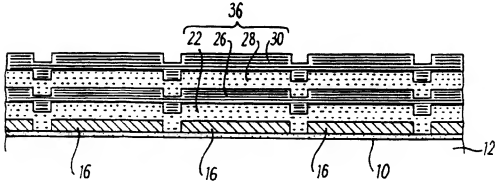

FIG. 6

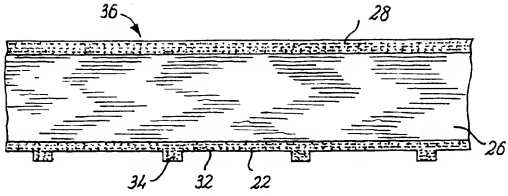

FIG. 7

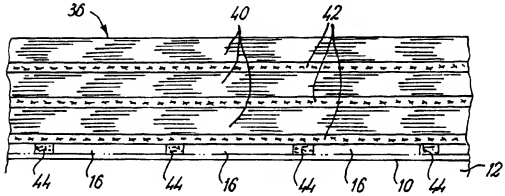

FIG. 8

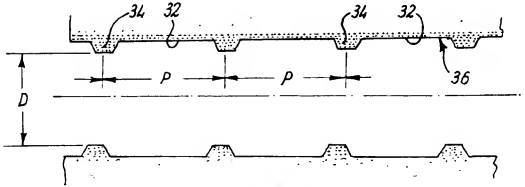

FIG. 9

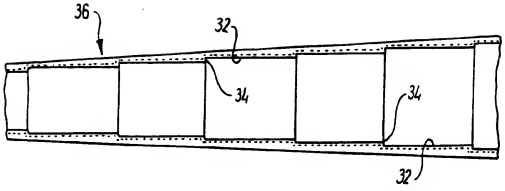

FIG. 10

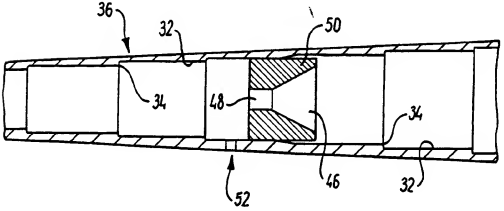

FIG. 11

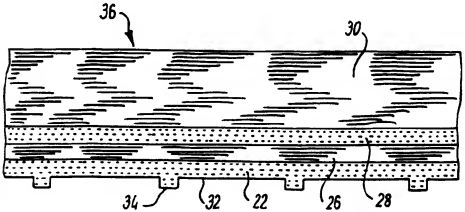

FIG. 12